ORTEC®

# TRUMP®-PCI-8K
# TRUMP®-PCI-2K
## Multichannel Buffer Card

## Hardware Manual

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Manual Revision E

**Advanced Measurement Technology, Inc.**

a/k/a/ ORTEC®, a subsidiary of AMETEK®, Inc.

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# Safety Instructions and Symbols

This manual contains up to three levels of safety instructions that must be observed in order to avoid personal injury and/or damage to equipment or other property. These are:

**DANGER** Indicates a hazard that could result in death or serious bodily harm if the safety instruction is not observed.

**WARNING** Indicates a hazard that could result in bodily harm if the safety instruction is not observed.

**CAUTION** Indicates a hazard that could result in property damage if the safety instruction is not observed.

In addition, the following symbols may appear on the product:

**DANGER–High Voltage**

**ATTENTION–Refer to Manual**

Please read all safety instructions carefully and make sure you understand them fully before attempting to use this product.

# Cleaning Instructions

To clean the instrument exterior:

- Disconnect the instrument from the power source.
- Remove loose dust on the outside of the instrument with a lint-free cloth.
- Remove remaining dirt with a lint-free cloth dampened in a general-purpose detergent and water solution. Do not use abrasive cleaners.

| | |
|---|---|
| **CAUTION** | To prevent moisture inside of the instrument during external cleaning, use only enough liquid to dampen the cloth or applicator. |

- Allow the instrument to dry completely before reconnecting it to the power source.

# 1. INTRODUCTION

The ORTEC TRUMP-PCI Multichannel Analyzer (MCA) brings our TRUMP multichannel buffer card into PCI format, giving you a computer-controlled multichannel pulse-height analyzer for high-performance data acquisition in nuclear spectroscopy applications.

The TRUMP-PCI-8K/-2K consists of a single-slot PCI card and the MAESTRO®-32 MCA Emulation Software for Microsoft® Windows 95, Windows 98, and Windows NT®.

Up to eight TRUMP-PCI cards can be controlled from the same PC under one copy of MAESTRO-32 with no overhead on the PC resources. During data acquisition the computer is entirely free to run other tasks.

A large number of ORTEC software applications support the TRUMP-PCI, and developer's toolkits are also available.

## 1.1. Using the Manual

This manual discusses the initial setup and installation of the TRUMP-PCI-8K/-2K card. For instructions on installing and operating MAESTRO-32, refer to the MAESTRO-32 *Software User's Manual*.

Chapter 1 of this manual gives a brief description of the TRUMP-PCI/MAESTRO-32 system. Chapter 2 gives the TRUMP-PCI card specifications. Chapter 3 tells how to set up and install the TRUMP-PCI card. Chapter 4 describes the basics of MCA operation. Chapter 5 explains the commands used to control the system for users who wish to write custom software to control the TRUMP-PCI card.

# 2. SPECIFICATIONS

## 2.1. Performance

**ADC** Successive-approximation type with sliding scale linearization.

**Resolution** Software selectable as 512, 1024, and 2048 for the TRUMP-PCI-2K, with addition choices of 4096 and 8192 for the TRUMP-PCI-8K.

**Dead Time Per Event** 9 μs, including memory transfer. Use the SET_RESET_DELAY and SHOW_RESET DELAY commands to decrease (to a minimum of 8 μs) or increase system dead time (see Section 5.4).

**Integral Nonlinearity** ≤±0.025% over the top 99% of the dynamic range.

**Differential Nonlinearity** <±1% over the top 99% of the dynamic range.

**Gain Instability** ≤±50 ppm/°C.

**Dead-Time Correction** Printed wiring board jumper selects either extended live-time correction according to the Gedcke-Hale[1] method, or simple live-time correction with the clock turned off during the conversion time.

**Data Memory** 8K channels of battery backed-up memory; $2^{31}-1$ counts per channel (over 2 billion).

**Presets**

- **Real Time/Live Time**: Multiples of 20 ms.
- **Region of Interest**: Peak count/Integral count.
- **Data Overflow**: Terminates acquisition when any channel exceeds $2^{31}-1$.
- **Peak Uncertainty**::Stops acquisition when the statistical or counting uncertainty of a user-selected net peak reaches the specified value.
- **Nuclide MDA**: Stops data collection when the value of the Minimum Detectable Activity (MDA) for a user-specified MDA nuclide reaches the specified value.

**Microprocessor** Intel 386; 32K × 16 RAM with battery backup; 4-Mbit flash memory.

---

[1]Ron Jenkins, R.W. Gould, and Dale Gedcke, *Quantitative X-Ray Spectrometry* (New York: Marcel Dekker, Inc.), 1981, pp 266−267.

## 2.2. Controls

**ADC Zero** Computer controlled, ±125 mV.

**ADC LLD** Computer controlled, from 0 to 100% full scale.

**ADC ULD** Computer controlled, from 0 to 100% full scale.

## 2.3. Inputs

**IN** (Input) Accepts positive unipolar, positive gated integrator, or positive leading bipolar analog pulses in the dynamic range from 0 to +10 V; +12 V maximum; semi-Gaussian- shaped or gated-integrator-shaped time constants from 0.25 to 30 μs, or delay-line-shaped with width >0.25 μs. $Z_{in} \approx 1$ kΩ, dc-coupled. No internal delay. BNC connector on rear panel.

**GATE** (ADC gate) Optional, slow-positive NIM input. Computer-selectable coincidence or anticoincidence. Signal must occur prior to and extend 0.5 μs beyond the peak of the pulse; rear-panel BNC connector. $Z_{in} \approx 1$ kΩ.

**PUR** Pile-up rejection input; accepts slow-positive NIM signal; signal must occur prior to peak detect. $Z_{in} \approx 1$ kΩ. BNC connector on rear panel.

**BUSY** Busy input used by live-time correction circuits. Accepts slow-positive NIM signal; signal must occur prior to peak detect. $Z_{in} \approx 1$ kΩ. BNC connector on rear panel.

## 2.4. Electrical and Mechanical

**Power Required** +5 V, 1.5 A.

**Dimensions** Standard full-slot PCI card.

## 2.5. Software Prerequisites

MAESTRO-32 runs on any PC that supports Windows 95, Window 98, or Windows NT.

# 3. INSTALLATION

This chapter tells how to set up a standard TRUMP-PCI system. Section 3.1 shows how to select extended or simple live-time correction mode. Section 3.2 describes how to install the TRUMP-PCI card. Section 3.3 discusses multiple-MCB systems. Section 3.4 contains the cabling requirements for a standard detector system. Sections 3.5 and 3.6 tell how to adjust the lower- and upper-level discriminators and the zero adjustment. Section 3.7 describes the Gate Input. Section 3.8 contains troubleshooting information.

## 3.1. Live-Time Mode

The TRUMP-PCI card has two different live-time correction modes; extended and simple. The extended mode is the Gedcke-Hale correction mode which corrects for losses caused by pile-up in the shaping amplifier. This is the default setting and is usually the correct setting for energy spectroscopy systems. The simple live-time correction mode simply stops the live-time clock when the BUSY signal is active, the TRUMP-PCI card detects that a pulse is arriving at its input, or the TRUMP-PCI card is busy digitizing data. The simple live-time mode is appropriate only in very specialized situations and is not the correct setting for most users.

Figure 1 shows the location of the live-time correction mode jumper J7. Remove the jumper for extended live-time correction, or leave it on for simple live-time correction.

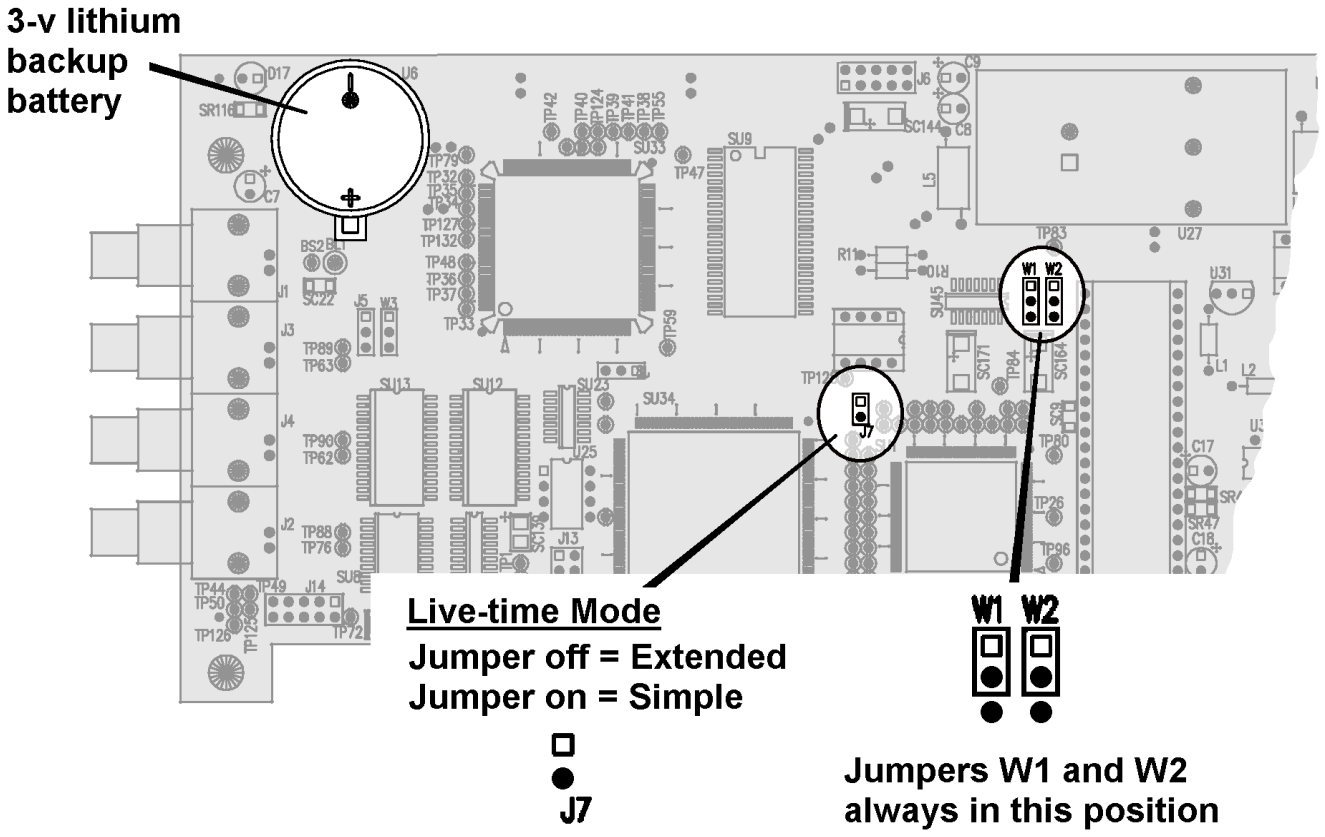


**Figure 1. TRUMP-PCI Jumper Settings and Backup Battery.**

## 3.2. Installing the TRUMP-PCI Card

| | |
|---|---|
| **CAUTION** | Always turn the PC off and unplug it from the mains power supply before installing a card. |

1. Remove the PC cover.

2. Remove the slot cover from an unused PCI slot.

3. Insert the card at an angle to get the BNC connectors through the opening on the rear of the PC, then press the card gently and firmly into the slot connector.

4. Fasten the card to the chassis with the option slot cover screw.

5. Replace the computer cover.

6. The TRUMP-PCI card uses a driver for communication with Windows. The driver file is supplied on floppy disk. To install the driver in Windows 95/98, install the card, restart the PC, and allow Windows to autodetect the new hardware. When Windows asks for the driver, browse the floppy disk for the file `PCITrump.ini` via a label, and click on **OK**. In Windows NT and when autodetect does not work, use **Start**, **Settings**, **Control Panel**, **Add New Hardware** to install the driver.

## 3.3. Setting Up a Multiple-MCB System

Up to eight ORTEC MCBs, in any combination, can be attached at one time to a single PC. To prevent conflicts in multiple-MCB systems, each MCB must be assigned a unique hardware address. This is done automatically in TRUMP-PCI cards so there are no jumpers or DIP switches for you to set. However, other types of MCBs may still require you to set jumpers or DIP switches; follow the instructions in the corresponding hardware manuals.

## 3.4. Cabling a System

The standard cabling of a TRUMP-PCI card in a HPGe detector system is shown in Fig. 2. If the detector has a TRP preamplifier ("-PLUS" model), all connections shown should be made. If the preamplifier is a resistive-feedback preamplifier, the INHIBIT OUTPUT does not exist, so the connection to INHIBIT is not made (INHIBIT is left open).

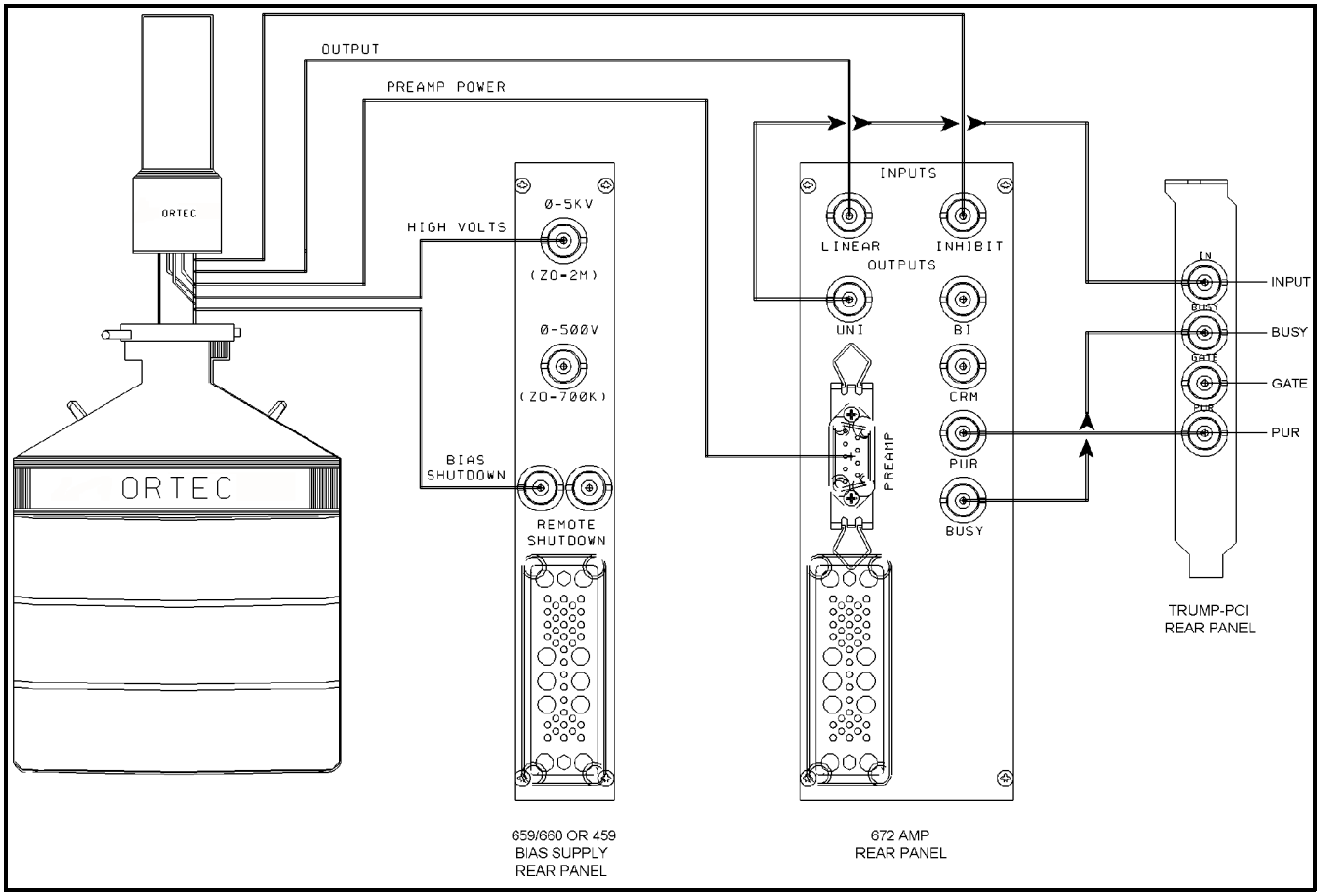


**Figure 2. HPGe System Cabling.**

## 3.5. Adjusting the Lower- and Upper-Level Discriminators

The lower-level discriminator (LLD) and upper-level discriminator (ULD) are set in MAESTRO with the **ADC Setup...** function under the **Acquire** menu. The LLD adjustment is used to prevent small noise pulses from being converted by the ADC. Converting the noise pulses causes the ADC to incur a large amount of dead time, which prevents the ADC from converting the actual pulses of interest.

When the TRUMP-PCI card is shipped from the factory, the LLD is set at 40 channels, and the ULD setting is 8000 channels. These are adequate for most systems.

If the system has high noise or there is a very low energy peak in the spectrum, it may be advantageous to adjust the LLD setting. In the high-noise system, start collecting data and observe the dead time on the screen along with the number of counts arriving at the low end of the spectrum. In MAESTRO, increase the LLD setting until the dead time drops or the peaks due to noise at the low end of the spectrum stop getting new counts.

If there is a low-energy peak in the spectrum, it may be necessary to lower the LLD setting to prevent the peak from being rejected. Start data acquisition and observe the low end of the spectrum while decreasing the LLD setting. Continue the adjustment until the peak is in the spectrum. *If the dead time goes to 100%, increase the LLD setting.*

## 3.6. Setting the Zero Adjustment

The zero adjustment adds or subtracts a dc level from the input signal. Set the zero adjustment in MAESTRO with the **ADC Setup...** function under the **Acquire** menu. Usually no zero adjustment is required or recommended since most modern spectroscopy amplifiers have very little dc offset.

## 3.7. Enabling the Gate Input

The GATE connector operates in one of three modes:

- *Off* — the Gate Input does nothing.
- *Coincident* — for a pulse to be converted, the Gate Input must be active (>2.5 V) when the pulse reaches its peak and for 0.5 µs thereafter.
- *Anticoincident* — for a pulse to be converted, the Gate Input must be inactive (<0.8 V) when the pulse reaches its peak and for 0.5 µs thereafter.

When the TRUMP-PCI card is shipped from the factory, the Gate Input is set *Off*. To change the setting, use **Acquire/ADC Setup...** in MAESTRO.

## 3.8. Troubleshooting

**Battery Backup Failed**The memory in the TRUMP-PCI has battery backup to maintain data when power is turned off. The battery is a lithium battery with a nominal voltage of 3 V.

The battery is located on the top left corner of the TRUMP-PCI card (see Fig. 1). It may be necessary to bend the battery holder down after removing the old battery to get good contact with the new battery.

**Battery Specification**:

- **Type** Lithium Coin Cell
- **Model** Panasonic CR-2354
- **ORTEC Part Number** 739480

# 4. MCA BASICS

This chapter contains some basic information about MCAs. ORTEC has taken the classical MCA and partitioned it into two components: an MCB and a PC. The MCB contains the circuitry required to create a spectrum while the personal computer is used for display of the spectrum and control of the instrument. The first half of this section describes the circuitry found on the TRUMP-PCI MCB, while the second half describes the dead-time effects encountered in an MCA.

## 4.1. MCB Operation

This section contains a very basic description of the input circuitry and the chain of events that occurs in the TRUMP-PCI card when an input pulse arrives to be histogrammed. Figure 3 shows the basic block diagram of the input section of the TRUMP-PCI MCB. First a description of each block in the circuit:

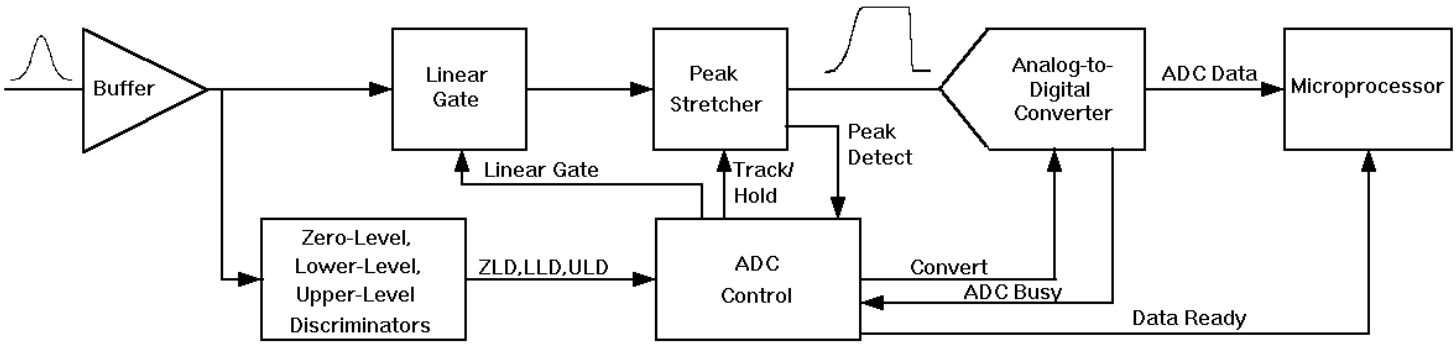


**Figure 3. TRUMP-PCI Input Block Diagram.**

- **Buffer** — The buffer is provided to properly match impedances between the input and the TRUMP-PCI circuitry.

- **Linear Gate** — The linear gate protects the peak stretcher during conversion of an event. When the linear gate is "open," its output is identical to its input. When the linear gate is "closed," its output is always zero.

- **Peak Stretcher** — The peak stretcher operates in one of two modes: Track or Hold. In Track mode, the output of the peak stretcher is identical to its input. In Hold mode, the peak stretcher acts like a maximum function. It outputs the maximum value which is applied to the input. The peak stretcher also has a peak-detect output which goes active when its output is greater than the value at its input.

- **Analog-to-Digital Converter** (ADC) — The ADC takes an analog signal and converts it to a digital equivalent.

- **Zero-Level, Lower-Level, and Upper-Level Discriminators** — These adjustments provide three control signals that help control the conversion process. The zero-level discriminator (ZLD) is active when the input signal is greater than half of the LLD setting. The LLD is active when the input signal is greater than the LLD setting. The ULD is active when the input signal is greater than the maximum possible ADC output.

- **ADC Control** — This circuit accepts all of the various status signals and provides the control signals required to complete a conversion.

- **Microprocessor** — The microprocessor accepts the digital data and adds it to the spectrum.

When an input pulse arrives, the sequence of events is as follows:

(1) ZLD goes active when the input reaches half of the LLD setting.

(2) When ZLD goes active, the peak stretcher is switched to Hold mode.

(3) When peak detect goes active, LLD, PUR, GATE and ULD are sampled. If any of these signals rejects the pulse, the peak stretcher is returned to Track mode. If the pulse is accepted, the linear gate is closed and the ADC is given the convert signal.

(4) When the ADC is finished converting, the data is transferred to the microprocessor for histogramming, the linear gate is opened and the peak stretcher is returned to Track mode.

## 4.2. Dead Time in MCA and Amplifier

When a detector, preamplifier, spectroscopy amplifier, and MCA are combined to form a spectroscopy system, the dead times of the amplifier and the MCA are in series. The combination of the amplifier-extending dead time followed by the MCA non-extending dead time $T_M$ yields a throughput described by:

$$r_o = \frac{r_i}{\exp[r_i(T_W + T_P)] + r_i[T_M - (T_W - T_P)]U[T_M - (T_W - T_P)]} \qquad \textbf{(1)}$$

The rate of events arriving at the detector is $r_i$, and $r_o$ is the rate of analyzed events in the MCA spectrum. $T_W$ is the width of the amplifier pulse at the noise discriminator threshold (Fig. 4). $T_P$ is the time from the start of the amplifier pulse to the point at which the MCA detects peak amplitude

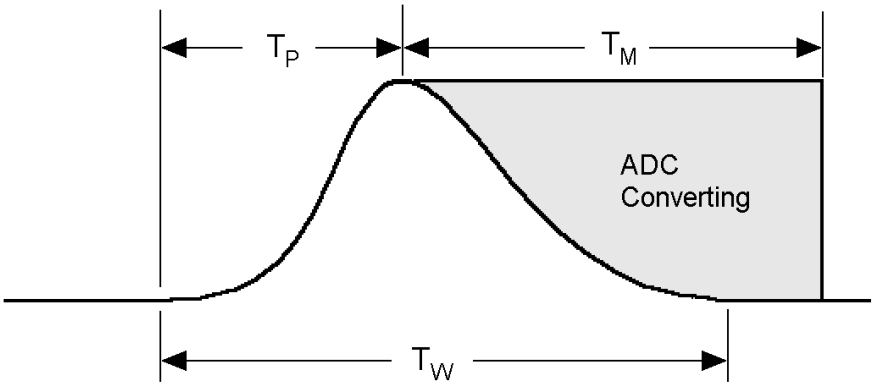


**Figure 4. The Sources of Dead Time with An Amplifier and MCA.**

and closes the linear gate. $U[T_M - (T_W - T_P)]$ is a unit step function that changes from 0 to 1 when $T_M$ is greater than $(T_W - T_P)$. $T_M$ is the conversion time of the ADC and includes the time required to transfer the data to the subsequent memory.

The TRUMP-PCI card Extended Live Timer uses the Gedcke-Hale method to correct for the dead-time losses implied by Eq. 1. When the counts in a full-energy peak are divided by the live time, the resulting counting rate is an accurate estimate of the true counting rate for that gamma-ray energy at the detector output. The Gedcke-Hale method uses the amplifier analog output, Busy, and PUR (pile-up-reject) signals. The amplifier dead time is combined with the ADC conversion and readout dead time to obtain the overall system dead time. For accurate live time, the PUR and BUSY signals must be connected from the amplifier to the TRUMP-PCI card.

The Gedcke-Hale live-time clock works as follows:

- Either the leading edge of the amplifier Busy signal or the crossing of the ADC LLD by the ADC Input causes the live-time clock to start counting backwards.

- The live-time clock is turned off by the ADC peak detect or by the amplifier PUR signal.

- The live-time clock resumes counting forward after all of the following signal conditions are satisfied:

    - The ADC conversion and readout is complete.
    - The ADC input has returned below the LLD threshold.
    - The PUR and BUSY signals have returned to the inactive state.

Turning off the live-time clock compensates for the probability of losing a second pulse during the processing of the first pulse. Subtracting live time compensates for the probability of losing two pulses when the second pulse distorts the amplitude of the first pulse.

# 5. COMMANDS AND RESPONSES

This chapter is intended for users who wish to write custom software to control the TRUMP-PCI card. For more information, see the MAESTRO-32 *Software User's Manual* or the ORTEC Universal MCB Interface (UMCBI) Toolkit (A11-B32).

Communication with a TRUMP-PCI card consists of sending command records to the MCB and receiving response records from the MCB. The records consist of a sequence of printable ASCII characters followed by an ASCII carriage return. All commands eventually respond with a percent response record (so named because it begins with an ASCII percent sign "%") which signifies the completion of the command. SHOW commands respond with a dollar response record (begins with an ASCII dollar sign "$") followed by a percent response record.

All characters up to the first carriage return or the end of the message are considered to be part of a command to the MCB.

## 5.1. Command Records

TRUMP-PCI commands contain a command header which may be followed by numeric parameter values. The header consists of a verb or a verb and noun separated by an underscore or a verb, noun, and modifier, each separated by underscores. The verbs, nouns, and modifiers in the command header are mnemonic words such as the verb ENABLE or the noun OVERFLOW that relate to the function performed by the MCB when it executes the command. The first four letters of any word will always be enough to uniquely identify the word when composing commands for an MCB. For example, the command **ENABLE_OVERFLOW_PRESET** can be abbreviated to **ENAB_OVER_PRES**.

Numeric parameters are unsigned integer numbers that follow the command header separated by one or more spaces. Specific commands require up to three parameters, separated by commas, which specify numeric quantities related to the operation of the MCB, such as live time or conversion gain. The command **SET_WINDOW 0,8192** has two parameters, 0 and 8192, which set the window of interest to start at channel 0 and continue for 8192 channels.

Some parameters listed in the command dictionary are considered optional and are distinguished from mandatory parameters by being surrounded by brackets in the command prototype line (e.g., **SET_WINDOW [start,length]**). Commands that have optional parameters may be sent to the MCB without the optional parameters, in which case the behavior will be changed as explained in the command description.

An optional checksum may be added to the end of any command sent to an MCB. The checksum is a 1-byte unsigned integer sum of all of the characters in a command, treated as unsigned integers, up to and including the comma or space(s) that separates the checksum from the

command. The checksum simply appears as an extra parameter added to the end of the command parameter list. For commands that do not normally have parameters, the checksum appears as the only parameter separated from the header by one or more spaces. All optional parameters must be included in a command if a checksum is to be provided so that the checksum is not mistaken by the MCB as a parameter. For example, the SET_WINDOW command must include the two optional parameters, start and length, if the checksum is provided (e.g., **SET_WINDOW 0,8192,159**).

## 5.2. Percent Response Records

TRUMP-PCI cards respond to all commands with a percent response record that signifies the completion of the command. Percent response records contain two error code numbers and a 1-byte checksum as follows:

**%aaabbbccc<CR>**

where % represents the ASCII % character, **aaa** represents the macro error code, **bbb** represents the micro error code, **ccc** represents the checksum and <CR> represents the ASCII carriage return character signifying the end of the record. The macro error code represents the general class of error with 0 meaning no error, and the micro error code represents the sub-class of error with 0 meaning no error. The following table lists all percent responses for a TRUMP-PCI.

**Unconditional Success:**

| | |
|---|---|
| %000000069 | No errors detected |

**START/STOP Warnings:**

| | |
|---|---|
| %000005074 | MCB already started or stopped |
| %000006075 | Preset already exceeded |

**Command Syntax Errors:**

| | |
|---|---|
| %129001082 | Invalid verb in command |
| %129002083 | Invalid noun in command |
| %129003084 | Invalid verb and noun in command |
| %129004085 | Invalid modifier in command |
| %129005086 | Invalid verb and modifier in command |
| %129006087 | Invalid noun and modifier in command |
| %129007088 | Invalid verb, noun, and modifier in command |
| %129132087 | Invalid command (verb, noun, and modifier valid, but not together) |

**Communication Errors:**

| | |
|---|---|
| %130128084 | Incorrect checksum (only if checksum provided) |
| %130129085 | Command record too long |

**Execution Errors:**

| | |
|---|---|
| %131128085 | Invalid 1st parameter |
| %131129086 | Invalid 2nd parameter |
| %131130078 | Invalid 3rd parameter |
| %131132080 | Invalid number of parameters |
| %131135083 | Illegal command while acquisition is in progress |
| %131136084 | Illegal command in current mode of operation |

## 5.3. Dollar Response Records

SHOW commands respond with a single dollar response record followed immediately by a percent response record. All valid dollar response records for each command are listed in the command dictionary.

The following table lists the general form of each dollar response record for a TRUMP-PCI MCB. In this table lowercase letters represent numeric values. The letters "**ccc**" always represent an 8-bit unsigned checksum of all characters on the record up to but not including the checksum characters, and **<CR>** represents the ASCII carriage return character.

| **Response** | **Description** |
|---|---|
| **$Axxxccc** | xxx is an 8-bit unsigned number |
| **$Cxxxxxccc** | xxxxxx is a 16-bit unsigned number |
| **$Dxxxxxyyyyyccc** | xxxxx and yyyyy are 16-bit unsigned numbers |
| **$Exxxxxccc** | xxxxx is a 16-bit alarm mask |
| **$Fssss...** | ssss... is a variable length ASCII character sequence (No checksum is sent with this record.) |
| **$Gxxxxxxxxxxccc** | xxxxxxxxxx is a 32-bit number |
| **$IT** | True response to a SHOW command (no checksum) |
| **$IF** | False response to a SHOW command (no checksum) |
| **$Jxxxxxyyyyy...ccc** | Response to SHOW_CONFIG command |
| **$Mxxxxxxxxxx...ccc** | Response to SHOW_STATUS command |
| **$Nxxxyyyzzzccc** | xxx, yyy, and zzz are 8-bit unsigned numbers |

# 5.4. Command Catalog

This section lists each TRUMP-PCI command with a description of its operation. The descriptions include a list of any unusual responses that may result. As described in previous sections, the usual response from a command is a **%000000069<CR>** response, which represents a macro error code of 0 and a micro error code of 0 (no errors).

All execution error responses, if any, are listed for each command. Though syntax and communication error responses may result from any command, in practice, these error responses rarely occur on systems with reliable communication hardware running debugged software. Refer to Section 5.2 for information about error responses.

In the following catalog the commands are listed in alphabetical order, each starting with a command prototype line. Uppercase letters, numeric digits, blank space, and special symbols such as the underscore "_" and comma "," in the prototype line are literal text to be sent to the MCB exactly as it appears. Lowercase letters in the prototype line represent numeric values as described in the accompanying text and should not be sent literally to the MCB but should be replaced by an appropriate numeric value. Items in the command prototype that are surrounded by brackets "[...]" are optional items and are not always required.

In this section the term **<CR>** represents the ASCII carriage return character, decimal value 13, and the character "_" represents the ASCII underscore character, decimal value 95.

**CLEAR**

The channels of spectral data in the window-of-interest (see SET_WINDOW command) are set to zero. The live-time and true-time counters are also set to zero. This command is equivalent to the combination of CLEAR_COUNTERS and CLEAR_DATA commands.

**CLEAR_ALL**

This command is equivalent to the combination of CLEAR_COUNTERS, CLEAR_DATA, CLEAR_PRESETS, and CLEAR_ROI commands.

Execution Errors:

**%131135083<CR>** The command was attempted while spectrum acquisition was in progress. No action was taken.

**CLEAR_COUNTERS**

The live-time and true-time counters are set to zero.

**CLEAR_DATA**

The channels of spectral data in the window-of-interest (see SET_WINDOW command). The ROI flags are not changed, nor are the presets changed.

**CLEAR_PRESETS**

The live time, true time, ROI integral, ROI peak, and overflow presets are all set to zero (disabled).

Execution Errors:

| | |
|---|---|
| **%131135083** | The command was attempted while spectrum acquisition was in progress. No action was taken. |

**CLEAR_ROI**

The region-of-interest flags for the channels in the window-of-interest (see SET_WINDOW command) are cleared.

Execution Errors:

| | |
|---|---|
| **%131135083** | The command was attempted while spectrum acquisition was in progress. No action was taken. |

**DISABLE_OVERFLOW_PRESET**

Disables the overflow preset. Channels that receive a count when they contain 2147483647 counts, the maximum number of counts, will roll over to zero counts if the overflow preset is disabled. See also ENABLE_OVERFLOW_PRESET and SHOW_OVERFLOW_PRESET.

**ENABLE_OVERFLOW_PRESET**

Enables the overflow preset. Channels that receive a count when they contain 2147483647 counts, the maximum number of counts, will stop the acquisition for that channel's device if the overflow preset is disabled. The channel that caused the preset to complete will contain 2147483647 counts. An alarm response record will be sent to the host if alarms are enabled (see ENABLE_ALARM command). See also DISABLE_OVERFLOW_PRESET and SHOW_OVERFLOW_PRESET commands.

**INITIALIZE**

Resets the TRUMP-PCI hardware and software as though the following commands have been issued:

```
STOP
SET_WINDOW 0,8192
SET_GATE_OFF
CLEAR_ALL
SET_GAIN_CONVERSION 0
```

This *completely clears all settings* as if the backup battery has failed.

Execution Errors:

The INITIALIZE command simulates a power-down/power-up cycle for the MCB after a simulated loss of battery backed-up memory.

**LIST_OFFSET_FINE**

Returns the minimum and maximum ADC offset settings in "real-world" units (channels), and the integer realization that will actually be used in the SET_OFFSET_FINE command.

Response:

**OFFSET_FINE –140 40 0 4095** The offset will be –140 channels when the SET_OFFSET_FINE 0 command is issued, and +140 channels when the SET_OFFSET_FINE 4095 command is issued. All other settings will have a linear relationship to these two endpoints.

**RESET**

Resets the TRUMP-PCI card to the state just after power is applied, applying the settings saved by the battery backup.

**SET_DATA** count

Sets all channels of spectral data in the window-of-interest (see SET_WINDOW command) for the currently selected device (see SET_DEVICE command) to the specified count. ROI flags are not affected.

**SET_DEVICE** device

Makes the specified device the currently selected device and remaps shared data memory so that the new device's channels are available. Only device number 1 is valid for a TRUMP-PCI. This command has no effect in the operation of the TRUMP-PCI.

Execution Errors:

**%131128085<CR>** An invalid device number was given.

**SET_GAIN_CONVERSION** chans

Sets the conversion gain. The conversion gain defines the number of channels within the device that will used for spectral data. This has the effect of altering the resolution of the ADC from 13/11 bits (conversion gain = 8192/2048) to 9 bits (conversion gain = 512) for the device.

Legal Commands:

**SET_GAIN_CONVERSION 0<CR>** Conv. gain set to default (8192 or 2048).
**SET_GAIN_CONVERSION 512<CR>** Conv. gain set to 512 channels.
**SET_GAIN_CONVERSION 1024<CR>** Conv. gain set to 1024 channels.
**SET_GAIN_CONVERSION 2048<CR>** Conv. gain set to 2048 channels.
**SET_GAIN_CONVERSION 4096<CR>** Conv. gain set to 4096 channels.
**SET_GAIN_CONVERSION 8192<CR>** Conv. gain set to 8192 channels.

**SET_GATE_ANTICOINCIDENT**

Causes the MCB to expect the ADC gate input signal in anticoincident mode. See the section on the ADC gate input for more information. See also SET_GATE_OFF, SET_GATE_COINCIDENT, and SHOW_GATE.

**SET_GATE_COINCIDENT**

Causes the MCB to expect the ADC gate input signal in coincident mode. See the section on the ADC gate input for more information. See also SET_GATE_OFF, SET_GATE_ANTICOINCIDENT, and SHOW_GATE.

**SET_GATE_OFF**

Causes the MCB to ignore the state of the ADC gate input signal. See the section on the ADC gate input for more information. See also SET_GATE_COINCIDENT, SET_GATE_ANTICOINCIDENT, and SHOW_GATE.

**SET_INTEGRAL_PRESET** count

Sets the ROI integral preset to the specified count. During data acquisition when the sum of the counts contained in the channels of a device that have the ROI flag set reaches the integral preset count, the preset is complete and the acquisition is stopped. The actual number of counts in the ROI integral may exceed the preset value by up to 512 counts due to the pipelined architecture of the TRUMP-PCI card. Setting an integral preset to 0 counts disables the preset. The integral preset may be set to from 0 (disabled) to 4294967295 counts. See also CLEAR_PRESETS and SHOW_INTEGRAL_PRESET.

Execution Errors:

**%131135083<CR>** The command was attempted while spectrum acquisition was in progress. No action was taken.

**SET_LIVE** ticks

Sets the live-time counter for the currently selected MCB to the specified number of ticks. The number represents live time in units of 20 ms (50 ticks per second). Normally this value is set by the TRUMP-PCI during data acquisition. See also CLEAR_COUNTERS and SHOW_LIVE.

Execution Errors:

**%131135083<CR>** The command was attempted while spectrum acquisition was in progress. No action was taken.

**SET_LIVE_PRESET** ticks

Sets the live-time preset to the specified number of ticks (20 ms). During data acquisition when the live-time counter reaches the preset number of ticks, the preset is complete and the acquisition is stopped. Setting a live time preset to 0 ticks disables the preset. See also CLEAR_PRESETS and SHOW_LIVE_PRESET.

Execution Errors:

**%131135083<CR>** The command was attempted while spectrum acquisition was in progress. No action was taken.

**SET_LLD** x

This sets the lower-level discriminator to the value x specified in channels.

**SET_MDA_COEF** a,b,c

Sets the coefficients in the MDA preset calculation to the specified values. A, b, and c are floating-point values. The MDA preset stops the calculation when the following condition is met:

$$MDA\ Preset > \frac{a + \sqrt{b + c * CountsinROI}}{Live\ Time}$$

The MDA preset calculation is performed once per minute.

**SET_MDA_PRESET** preset

Sets the MDA preset to the specified value. The preset is the product of the desired MDA, the efficiency, and the yield.

**SET_OFFSET_FINE** offset

Changes the ADC offset. Offset is a value from 0 to 4095. When offset is zero, an offset of approximately −140 channels (at 8192 conversion gain) is applied. When offset is 2048, no shift is applied to the spectrum.

**SET_PEAK_PRESET** count

Sets the ROI peak preset to the specified count. During data acquisition when the contents of any channel of a device that has the ROI flag set reaches the peak preset count, the preset is complete and the acquisition is stopped. The actual number of counts in the ROI peak may exceed the preset value by a small number of counts due to the pipelined architecture of the TRUMP-PCI card. Setting a peak preset to 0 counts disables the preset. The peak preset may be set to from 0 (disabled) to 2147483647 counts. See also CLEAR_PRESETS and SHOW_PEAK_PRESET.

Execution Errors:

**%131135083<CR>** The command was attempted while spectrum acquisition was in progress. No action was taken.

**SET_RESET_DELAY** delayticks

Inserts dead time into the system between the completion of one acquisition cycle and the beginning of the search for a new pulse, and adds to the TRUMP-PCI's 8-µs minimum dead

time. Delayticks represents the amount of time added (1 delaytick = ~80 ns). The default value for delayticks is 20 (~1.2 μs of delay, resulting in a default dead time of ~9.2 μs), and can be set anywhere between 1 and $2\times10^{16}-1$. *Setting the reset delay to zero results in no pulse* (essentially an infinite delay).

This delay is needed only when the stretcher capacitor has not had enough time to completely discharge, in which case, double-peaking might be observed. In these instances, the delay should be needed only with input pulses less than 2 μs in width. Consequently, for systems using a 2-μs input pulse, the reset delay can be set to 1.

Example:

| | |
|---|---|
| **SET_RESET_DELAY 1** | Add 80 ns to the reset delay so total reset delay = 8.08 μs. |

**SET_ROI** start_chan, number_of_chans

Sets the ROI flags for the specified channels. This command can be used multiple times to set ROI flags without affecting previously set flags. ROI flags specify channels within a device that are considered for ROI integral and ROI peak presets.

**SET_ROI_MDA** start,chans

Sets the region to be used for the MDA preset calculation.

**SET_ROI_UNCERTAINTY** start, chans

Sets the region to be used for the uncertainty preset calculation. See also SHOW_ROI_UNCERTAINTY.

**SET_TRUE** ticks

Sets the true-time counter for the currently selected MCB to the specified number of 20-ms ticks. The number represents true time in units of 20 ms (50 ticks per second). Normally this value is set by the TRUMP-PCI during data acquisition. See also CLEAR_COUNTERS and SHOW_TRUE.

Execution Errors:

| | |
|---|---|
| **%131135083<CR>** | The command was attempted while spectrum acquisition was in progress. No action was taken. |

**SET_TRUE_PRESET** ticks

Sets the true-time preset to the specified number of ticks (20 ms). During data acquisition when the true-time counter reaches the preset number of ticks, the preset is complete and the acquisition is stopped. Setting a true-time preset to 0 ticks disables the preset. See also CLEAR_PRESETS and SHOW_TRUE_PRESET.

Execution Errors:

| | |
|---|---|
| **%131135083<CR>** | The command was attempted while spectrum acquisition was in progress. No action was taken. |

**SET_ULD** i

This sets the upper-level discriminator to the value of i, in channels.

**SET_UNCERTAINTY_PRESET** percent

Sets the uncertainty preset to the specified value in percent. percent is a floating point value from 0–99.9999. See also SHOW_UNCERTAINTY_PRESET.

Execution Errors

| | |
|---|---|
| **%131128085<CR>** | The value is incorrect. |
| **%131132080<CR>** | A value must be included. |

**SET_WINDOW** [start, length]

Sets the window-of-interest to the specified start channel and number of channels. The channels of spectral data in the window-of-interest are affected by commands such as CLEAR and SET_DATA. If neither start or length is provided, the window is set to the maximum size allowed by the conversion gain specified for the currently selected device. The window-of-interest is always set to the maximum size after a SET_DEVICE command or a SET_SEGMENT command.

Execution Errors:

| | |
|---|---|
| **%131128085<CR>** | The start channel was too high for the conversion gain. |
| **%131129086<CR>** | The length specified one or more channels that were too high for the currently selected device's conversion gain. |
| **%131132080<CR>** | The start channel was specified without a length. If one value is given the other must be also given. |

**SHOW_ACTIVE**

Returns a 1 if the ADC is active, acquiring spectral data, or 0 if it is not active.

Responses:

| | |
|---|---|
| **$C00000087<CR>** | The ADC is not active. |
| **$C00001088<CR>** | The ADC is active. |

**SHOW_ADC_CONVERSION**

This shows the channel value for the last conversion by the ADC, as a $C record.

**SHOW_CONFIGURATION**

Returns a record that indicates the hardware configuration of the MCB. The record contains information about the number of segments in an MCB device (always one for the TRUMP-PCI), and the current conversion gain for each segment. The record is organized as follows:

**$J0819200001aaaaa00000" 65 zeros here for total of 75 zeros "00000ccc** for 8K
**$J0204800001aaaaa00000" 65 zeros here for total of 75 zeros "00000ccc** for 2K

Where **aaaaa** represents the conversion gain for the one and only segment in the currently selected device, and **ccc** represents the record checksum. See the section on response records in this appendix for more information about response records and checksums.

**SHOW_CONFIGURATION_MASK**

Returns two masks, the first of which may be "anded" with data from the MCB to clear the ROI bit from the data. When the second mask value is "anded" with data from the MCB, the data bits are removed and only the ROI bit remains.

Response:

**CONF_MASK 02147483647 02147483648**

**SHOW_FEATURES**

This command returns the hardware feature mask to show which features are available in the selected MCB.

Response:

**FEATURES: 0000000000 0000000000 0000000000**

Feature mask bit definition (bit number starts on right):

| TRUMP-PCI | Bit | Meaning |
|---|---|---|
| 1 | 0 | Software-selectable conversion gain |
| 0 | 1 | Software-selectable coarse gain |
| 0 | 2 | Software-selectable fine gain |
| 0 | 3 | Gain stabilizer |
| 0 | 4 | Zero stabilizer |
| 1 | 5 | PHA-mode functions available |
| 0 | 6 | MCS-mode functions available |
| 0 | 7 | List-mode functions available |
| 0 | 8 | Sample-mode functions |
| 0 | 9 | Digital offset (i.e., 920) |
| 1 | 10 | Software-selectable analog offset |
| 0 | 11 | HV power supply |
| 0 | 12 | Enhanced HV (SH_HV_POL, SH_HV_ACT, etc.) |
| 0 | 13 | Software-selectable HV range (ENA_NAI, DIS_NAI) |

| TRUMP-PCI | Bit | Meaning |
|---|---|---|
| 0 | 14 | Auto PZ |
| 0 | 15 | Software-selectable manual PZ |
| 0 | 16 | Battery-backed real-time clock |
| 0 | 17 | Sample changer support |
| 0 | 18 | One-button acqquisition via ENAB_TRIG_SPEC and MOVE commands |
| 0 | 19 | Nomadic (likely to move between opens) |
| 0 | 20 | Local app data (SET_DATA_APP, SHOW_DATA_APP) |
| 1 | 21 | Software retrievable serial number (SHOW_SNUM) |
| 0 | 22 | Power management features (CONSERVE, ON, OFF, etc.) |
| 0 | 23 | Battery status support (SH_STAT_BATT) |
| 0 | 24 | Software-selectable AMP polarity |
| 0 | 25 | Flattop optimization (START_OPTI cmd) |
| 0 | 26 | Stoppable Auto PZ (STOP_PZ_AUTO cmd) |
| 0 | 27 | Network support (i.e., DSPEC®) |
| 0 | 28 | Multi-drop serial support (i.e., MicroNOMAD®) |
| 0 | 29 | Software-selectable DPM address (SET_DPM_ADDR) |
| 0 | 30 | Multiple devices (i.e., 919) |
| 1 | 31 | Software-selectable ADC gate mode (SET_GATE...) |

**Beginning of 2nd word**

| | | |
|---|---|---|
| 1 | 32 | Software downloadable firmware |
| 0 | 33 | Time histogramming functions available (i.e., 9308) |
| 1 | 34 | Software-selectable LLD |
| 1 | 35 | Software-selectable ULD |
| 0 | 36 | MCS-mode SCA input available |
| 0 | 37 | MCS-mode TTL input available |
| 0 | 38 | MCS-mode fast neg NIM input available |
| 0 | 39 | MCS-mode discriminator input available |
| 0 | 40 | Switchable MCS-mode discriminator edge |

| TRUMP-PCI | Bit | Meaning |
|---|---|---|
| 0 | 41 | Programmable MCS-mode discriminator level |
| 0 | 42 | Programmable SCA |
| 0 | 43 | Software-selectable MCS mode input sources |
| 1 | 44 | Statistical preset (SET_UNCERT_PRES) |
| 0 | 45 | Features vary by input (multi-input MCBs only) |
| 0 | 46 | Software-selectable HV shutdown (SET, SHOW, VERI_SHUT) |
| 0 | 47 | Software-selectable shaping time (SET_SHAP) |
| 0 | 48 | Explorable shaping time (SHOW_CONF_SHAP) |
| 0 | 49 | Advanced shaping time (SET_SHAP_RISE, etc.) |
| 0 | 50 | Software settable BLR (ENA_BLR_AUTO, etc.) |
| 1 | 51 | SHOW_STATUS command supported with $M response |
| 1 | 52 | Overflow preset (ENA/DIS/SHO_OVER_PRES) |
| 0 | 53 | MicroNOMAD-style clicker (ENAB_CLICK, DISA_CLICK, etc.) |
| 0 | 54 | Thermistor support (SHOW_THERM) |
| 0 | 55 | Floating-point fine gain (SET/SHOW_GAIN_FINE) |
| 0 | 56 | Settable PUR (ENA_PUR, SET_WIDT_REJ, VERI_WIDT_REJ) |
| 0 | 57 | Alpha-style HV PS (SHOW_HV_CURR) |
| 0 | 58 | Readable vacuum (SHOW_VACUUM) |
| 0 | 59 | Acquisition alarm (ENA/DIS/SHO_ALARM) |
| 0 | 60 | Hardware acquisition trigger (ENA/DIS/SHO_TRIG) |
| 0 | 61 | Ordinal numbers accepted for SET_SHAP |
| 1 | 62 | Explorable gains (LIST/VERI_GAIN_FINE, ...COAR, ...CONV) |
| 0 | 63 | Routable inputs (SET/SHOW_INPUT_ROUTE) |

| TRUMP-PCI | Bit | Meaning |
|---|---|---|
| **Beginning of 3rd word** | | |
| 0 | 64 | External dwell support (ENA/DIS_DWELL_EXT) |
| 0 | 65 | Selectable SUM or REPLACE MCS modes (ENA/DIS_SUM) |
| 0 | 66 | External start of pass is set with ENA/DIS_START_EXT |
| 0 | 67 | MCS list commands present (LIST_ULSCA, LIST_LLSCA, LIST_SOURCE |
| 1 | 68 | MDA Preset |
| 0 | 69 | Programmable external ADC Type |
| 0 | 70 | Programmable printer-port daisy chain (ENAB_DAIS) |

**SHOW_GAIN_CONVERSION**

This command returns the conversion gain.

Responses:

| | |
|---|---|
| **$C00512095<CR>** | Conversion gain reported as 512 channels. |
| **$C01024094<CR>** | Conversion gain reported as 1024 channels. |
| **$C02048101<CR>** | Conversion gain reported as 2048 channels. |
| **$C04096106<CR>** | Conversion gain reported as 4096 channels (8K only). |
| **$C08192107<CR>** | Conversion gain reported as 8192 channels (8K only). |

**SHOW_GATE**

Reports the current mode of operation of the ADC gate input. See also SET_GATE_OFF, SET_GATE_COINCIDENT, and SET_GATE_ANTICOINCIDENT.

Responses:

| | |
|---|---|
| **$FOFF<CR>** | Reports the ADC gate is off or ignored. |
| **$FCOI<CR>** | Reports the ADC gate is in coincident mode. |
| **$FANT<CR>** | Reports the ADC gate is in anticoincident mode. |

**SHOW_INTEGRAL** [start_chan, number_of_chans]

Reports the sum of the specified group of spectral data channels. If start_chan and number_of_chans is not provided, SHOW_INTEGRAL reports the sum of all channels that have their ROI flag set.

Responses:

| | |
|---|---|
| **$G0000000000075<CR>** | Integral reported as 0. |
| **...** | **...** |
| **$G4294967294131<CR>** | Integral reported as 4294967294. |
| **$G4294967295132<CR>** | Integral reported as greater than or equal to 4294967295 (maximum reportable value). |

**SHOW_INTEGRAL_PRESET**

Reports the current ROI integral preset value. See SET_INTEGRAL_PRESET for more information about the ROI integral preset. See also SHOW_INTEGRAL.

Responses:

| | |
|---|---|
| **$G0000000000075<CR>** | Integral preset reported as 0. |
| **...** | **...** |
| **$G4294967295132<CR>** | Integral reported as 4294967295. |

**SHOW_LIVE**

Reports the contents of the live-time counter in units of 20 ms (50 ticks per second). See also CLEAR_COUNTERS and SET_LIVE.

Responses:

| | |
|---|---|
| **$G0000000000075<CR>** | Live time reported as 0 ticks. |
| **$G0000000001076<CR>** | Live time reported as 1 tick (20 ms). |
| **...** | **...** |
| **$G4294967295132<CR>** | Live time reported as 4294967295 ticks (over 23000 days). |

**SHOW_LIVE_PRESET**

Reports the current live-time preset in units of 20 ms (50 ticks per second). See also CLEAR_PRESETS and SET_LIVE_PRESET.

Responses:

| | |
|---|---|
| **$G0000000000075<CR>** | Live time preset reported as disabled. |
| **$G0000000001076<CR>** | Live time preset reported as 1 tick. |
| **...** | **...** |
| **$G4294967295132<CR>** | Live time preset reported as 4294967295 ticks. |

**SHOW_LIVE_REMAINING**

This returns the live time remaining until the live-time preset is reached. The number of 20-ms ticks is returned in a $G record.

**SHOW_LLD**

This returns the lower-level discriminator setting in channels as a $C record. See also SET_LLD.

**SHOW_MDA**

Returns the uncorrected MDA in gammas/s by calculating the right half of the MDA equation (see SET_MDA_COEF) and returns that value.

Example Responses:

**MDA 000000000000.85** MDA = 0.85.

**SHOW_MDA_COEFFICIENTS**

Returns the coeffficients used for the MDA calculation. See SET_MDA_COEFFICIENTS.

Example Responses:

**MDA_COEF 000000000002.71 000000000000000 0000000000021.7**

Coefficient a = 2.71, b = 0, and c = 21.7.

**SHOW_MDA_PRESET**

Returns the current MDA preset setting.

Example Responses:

**MDA 000000000000000** No preset.

**MDA 0000000000008.5** Preset set to 8.5%.

**SHOW_MODE**

This command is for compatibility with Model 918 systems. It always reports that the TRUMP-PCI card operates in pulse-height analysis mode.

Responses:

**$FPHA<CR>**

**SHOW_NEXT**

Used in conjunction with the SHOW_ROI command, SHOW_NEXT reports the next continuous group of channels that have the ROI flag set. The response is of the form:

**$Dsssssnnnnnccc<CR>**

where sssss represents an integer number that is the number of the first channel of the "next" group of channels that all have their ROI bit set, and nnnnn represents an integer number that is the number of channels in the group. If no more channels have their ROI bit set, SHOW_NEXT returns a first channel of 0 and a number of channels of 0. The SHOW_ROI command is used to report the "first" group of channels that all have their ROI bit set.

Example Responses:

**$D0100000050078<CR>** Next ROI group starts at channel 1000 and is 50 channels long.

**$D0215000150086<CR>** Next ROI group starts at channel 2150 and is 150 channels long.

**$D0000000000072<CR>** No other ROI groups to report.

**SHOW_OFFSET_FINE**

Returns the current ADC offset.

Example Responses:

| | |
|---|---|
| **$C02048101** | Offset is 2048 hardware units or 0 channels. |
| **$C00000087** | Offset is 0 hardware units or −140 channels. |

**SHOW_OVERFLOW_PRESET**

Reports the state of the overflow preset.

Responses:

| | |
|---|---|
| **$IT<CR>** | Overflow preset enabled. |
| **$IF<CR>** | Overflow preset disabled. |

**SHOW_PEAK**

This command returns the contents of the ROI channel with the largest number of counts. An ROI channel is a channel that has the ROI flag set. The maximum possible value is 2147483647, which is the maximum number of counts that can be stored in a 31-bit channel.

Responses:

| | |
|---|---|
| **$G0000000000075<CR>** | Maximum count in an ROI channel is zero or no ROI channels were found. |
| **$G0000000001076<CR>** | Maximum count in an ROI channel is 1. |
| **...** | **...** |
| **$G2147483646120<CR>** | Maximum count in an ROI channel is 2147483646. |
| **$G2147483647121<CR>** | Maximum count in an ROI channel is 2147483647. |

**SHOW_PEAK_CHANNEL**

This command returns the number of the ROI channel with the largest number of counts. An ROI channel is a channel that has the ROI flag set. The lowest number ROI channel with the largest count is reported if more that one channel contains the largest number of counts. Channel 16383 is the highest numbered channel in any device.

Responses:

| | |
|---|---|
| **$C00000087<CR>** | Maximum count was found in channel 0 or no ROI channels were found. |
| **$C00001088<CR>** | Maximum count was found in channel 1. |
| **...** | **...** |
| **$C08190105<CR>** | Maximum count was found in channel 8190. |
| **$C08191106<CR>** | Maximum count was found in channel 8191. |

**SHOW_PEAK_PRESET**

Reports the value of the ROI peak preset. See SET_PEAK_PRESET for information about the ROI peak preset.

Responses:

| | |
|---|---|
| **$G0000000000075<CR>** | Peak preset disabled. |
| **$G0000000001076<CR>** | Peak preset set to 1 count. |
| **...** | **...** |
| **$G2147483646120<CR>** | Peak preset set to 2147483646 counts. |
| **$G2147483647121<CR>** | Peak preset set to 2147483647 counts. |

**SHOW_RADIX**

This command is for compatibility with other ORTEC MCBs. It always reports that the number base radix for the WRITE command is binary.

Responses:

| | |
|---|---|
| **$FBIN<CR>** | Number base set to binary radix. |

**SHOW_RESET_DELAY**

Returns the current reset delay value added to the TRUMP-PCI's 8-µs minimum dead time. Each unit of reset delay time (a *delaytick*) represents ~80 ns. See SET_RESET_DELAY.

Responses:

| | |
|---|---|
| **$C00001088<CR>** | Reset delay is 1 delaytick. |
| **$C00020088<CR>** | Reset delay is 20 delayticks. |

**SHOW_ROI**

Used in conjunction with the SHOW_NEXT command, SHOW_ROI reports the first continuous group of channels that have the ROI flag set. The response is of the form:

**$Dsssssnnnnnccc<CR>**

where sssss represents an integer number that is the number of the first channel of the "first" group of channels that all have their ROI bit set, and nnnnn represents an integer number that is the number of channels in the group. The SHOW_NEXT command is used to report the "next" group of channels that all have their ROI bit set.

Responses:

| | |
|---|---|
| **$D0100000050078<CR>** | First ROI group starts at channel 1000 and is 50 channels long. |
| **$D0215000150086<CR>** | First ROI group starts at channel 2150 and is 150 channels long. |
| **$D0000000000072<CR>** | No ROI groups to report. |

**SHOW_ROI_MDA**

Reports the start channel and number of channels used in the MDA preset calculation.

Example Response:

| | |
|---|---|
| **$D0700000050ccc** | Calculation is performed on channels 7000–7049. |

**SHOW_ROI_UNCERTAINTY**

Reports the start channel and number of channels used in the uncertainty preset calculation. See also SET_ROI_UNCERTAINTY.

Response:

**$D0700000050ccc** Calculation is performed on channels 7000–7049.

**SHOW_SNUM**

Returns an $F record and the serial number of the TRUMP-PCI. See SET_SNUM.

Responses:

**$F115** TRUMP-PCI serial number is 115.

**SHOW_STATUS**

In PHA mode, returns system status information in the following format:

**$Mlllllllllltttttttttaaaaahhhhhccc<CR>**

where **lllllllll** represents the live time as returned by the SHOW_LIVE command, **ttttttttt** represents the true time as returned by the SHOW_TRUE command, **aaaaa** represents the active device mask as returned by the SHOW_ACTIVE_DEVICES command, and **hhhhh** represents the hardware status, which is an ASCII representation of a 16-bit decimal number with the following bit definitions:

| | |
|---|---|
| Bit 0 (LSB) | Bias supply polarity (0 = positive, 1 = negative). |
| Bit 1 | Bias supply overload (0 = overload, 1 = normal). |
| Bit 2 | HV enabled (0 = disabled, 1 = enabled). |
| Bit 3 | Unused. |
| Bit 4 | Amplifier PZ'd since initialization (0 = normal, 1 = needs PZ'ing). |
| Bit 5 | Unused. |
| Bit 6 | Waiting for MCS to finish current sweep after STOP command (0 = normal, 1 = waiting for completion). |
| Bit 7 | Unused. |
| Bit 8 | Amplifier automatic PZ (0 = normal, 1 = Auto PZ in progress). |
| Bits 9 | Unused. |
| Bit 10 | Power conservation mode (0 = full power, 1 = conservation). |
| Bit 11 | Waiting for start delay (0 = ready, 1 = waiting) |
| Bit 12 | Main Battery 2 In Use (0 = battery 1 in use, 1 = battery 2 in use). |
| Bit 13 | Main Battery 1 Low Warning (0 = normal, 1 = battery voltage low). |
| Bit 14 | Main Battery 2 Low Warning (0 = normal, 1 = battery voltage low). |
| Bit 15 (MSB) | Unused. |

In MCS mode, returns system status information in the form:

**$Mpppppppppppccccccccccaaaaahhhhhccc**

where **ppppppppppp** is the pass count as returned by SHOW_PASS command **ccccccccccc** is the current channel as returned by SHOW_CHANNEL, **aaaaa** and **hhhhh** are the same as in PHA mode, and **ccc** is the checksum.

**SHOW_TRUE**

Reports the contents of the true-time counter in units of 20 ms (50 ticks per second). See also CLEAR_COUNTERS and SET_TRUE.

Responses:

| | |
|---|---|
| **$G0000000000075<CR>** | True time reported as 0 ticks. |
| **$G0000000001076<CR>** | True time reported as 1 tick (20 ms). |
| **...** | **...** |
| **$G4294967295132<CR>** | True time reported as 4294967295 ticks (over 23000 days). |

**SHOW_TRUE_PRESET**

Reports the current true-time preset in units of 20 ms (50 ticks per second). See also CLEAR_PRESETS and SET_TRUE_PRESET.

Responses:

| | |
|---|---|
| **$G0000000000075<CR>** | True-time preset reported as disabled. |
| **$G0000000001076<CR>** | True-time preset reported as 1 tick. |
| **...** | **...** |
| **$G4294967295132<CR>** | True-time preset reported as 4294967295 ticks. |

**SHOW_TRUE_REMAINING**

This returns the true (real) time remaining until the real time preset is reached. The number of 20-ms ticks is returned in a $G record.

**SHOW_ULD**

This returns the value of the upper-level discriminator in channels as a $C record.

**SHOW_UNCERTAINTY**

Returns the current value of the uncertainty for the peak in the uncertainty preset. See also SET_UNCERTAINTY.

Responses:

| | |
|---|---|
| **UNCE 0000000000008.5** | Uncertainty of the peak is 8.5%. |

**SHOW_UNCERTAINTY_PRESET**

Returns the current uncertainty preset setting. See also SET_UNCERTAINTY_PRESET.

Responses:

| | |
|---|---|
| **UNCE_PRES 000000000000000** | No preset. |
| **UNCE_PRES 0000000000008.5** | Preset set to 8.5%. |

**SHOW_VERSION**

Reports the firmware version number in the form: **Fmmmm-vvv<CR>**
where **mmmm** is a 4-character model designator and **vvv** is a 3-character version designator.

Example Responses:

| | |
|---|---|
| **$FTRMP-001<CR>** | TRUMP-PCI firmware version 1 reported. |

**SHOW_WINDOW**

Reports the start channel and number of channels that are in the window-of-interest for the currently selected device in the form:

**$Dxxxxxyyyyyccc<CR>**

where **xxxxx** is the start channel (0 through 8191) and **yyyyy** is the number of channels (1–8192). See SET_WINDOW for more information about the window-of-interest.

Example Responses:

| | |
|---|---|
| **$D0000008192092<CR>** | Window-of-interest reported as starting at channel 0 and continuing for 8192 channels |

**START** [seg-mask]

Starts the acquisition of spectral data. The optional segment mask is provided for compatibility with other MCBs and may be any value from 0 to 65535 but is ignored by the TRUMP-PCI card.

Execution Warnings:

| | |
|---|---|
| **%000005074<CR>** | The acquisition is already started (no changes made). |
| **%000006075<CR>** | A preset was exceeded (acquisition was not started). |

**STEP_OFFSET_FINE**

Increases the fine offset by 1 hardware unit. Returns the new setting in a $C record.

**STOP** [seg-mask]

Stops the acquisition of spectral data. The optional segment mask is provided for compatibility with other MCBs and may be any value from 0 to 65535 but is ignored by the TRUMP-PCI card.

Execution Warnings:

| | |
|---|---|
| **%000005074** | Acquisition already stopped (no changes made) |

# APPENDIX A. GLOSSARY

**ACQUISITION**

The process of collecting data from a detector and storing the data in memory.

**ASCII**

American Standard Code for Information Interchange. The ASCII code is defined by ANSI (American National Standards Institute) standard X3.4-1977. This standard describes the representation of characters as 8-bit binary numbers. This representation for characters is used by most mini and personal computers.

**CHECKSUM**

The sum of bytes in a record used to detect when communication errors occur.

**CLOCK**

A component of a device that keeps track of some form of time. TRUMP-PCI MCBs have live-time and true-time clocks.

**COUNTER**

Another name for a TRUMP-PCI clock (live-time or true-time).

**DEAD TIME**

The time that data acquisition is active but the MCB cannot process detector pulses (is dead). Dead time for a device is equal to the true time minus the live time.

**DEVICE**

The entity within an MCB that collects and stores spectral data. A device corresponds to the MCB's inputs.

Model 919 MCBs have 4 inputs and thus 4 devices, while TRUMP-PCIs have only 1 input and thus 1 device. A device can be selected, started, stopped, and cleared.

**HOST**

The computer that sends commands to an MCB and receives responses from the MCB.

**LIVE TIME**

The time that data acquisition is active and the MCB is capable of processing detector pulses (is live). Live time for a device is equal to the true time minus the dead time.

**PRESET**
A limit set for a clock or region-of-interest count that if exceeded during an acquisition will cause the acquisition to stop. TRUMP-PCIs have live time, true time, ROI integral, ROI peak, overflow, MDA, and peak uncertainty presets for each device in the MCB.

**PROGRAM MEMORY**
The flash memory on the TRUMP-PCI card that contains the microprocessor instructions and fixed data for controlling the operation of the MCB.

**RAM**
Random access memory.

**RECORD**
A sequence of related bytes. TRUMP-PCI command, percent and dollar records are composed of printable ASCII characters and end with an ASCII carriage return.

**ROI CHANNEL**
A channel that has the region-of-interest (ROI) flag set.

**ROI FLAG**
A set of internal MCB flags (one for each channel) which, when set, identifies the channel as being part of the region of interest. All channels in a device that have the ROI flag set are considered when ROI integral or ROI peak presets are evaluated.

**SEGMENT**
A subdivision of a device. Segments are not implemented on TRUMP-PCIs and are referenced only for compatibility with other MCBs.

**TICK**
The minimum unit of time associated with a clock such as the real-time or live-time clocks — a clock tick.

**TRUE TIME**
The actual time that data acquisition is active regardless of the MCB's ability to process detector pulses. True time is also known as real time.

**WINDOW OF INTEREST**
The continuous group of channels affected by commands like CLEAR, and SET_DATA. The window-of-interest is set by the SET_WINDOW command, as well as by the SET_DEVICE and SET_SEGMENT commands.

ADC gate . . . . . 19, 26
ADC LLD . . . . . 4
ADC Zero . . . . . 4
Analog-to-Digital Converter . . . . . 10
Battery . . . . . 8
BUSY . . . . . 4
Command Catalog . . . . . 16
Conversion gain . . . . . 18
Dead Time . . . . . 3, 10
Differential Nonlinearity . . . . . 3
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Gedcke-Hale . . . . . 5, 11
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Integral . . . . . 27
Integral Nonlinearity . . . . . 3
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Overflow preset . . . . . 17, 29
PEAK . . . . . 29
Peak Channel . . . . . 29
Peak Stretcher . . . . . 9
POWER . . . . . 4
Presets . . . . . 3
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RESET . . . . . 18
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